Fast Acting Flow Control Valve, Phase II Project

SBIR/STTR Programs | Space Technology Mission Directorate (STMD)

ABSTRACT

High power electric propulsion systems have the potential to revolutionize space propulsion due to their extremely high performance. This can result in significant propellant savings on space vehicles, allowing the overall mass to shrink for launch on a less expensive vehicle or to allow the space vehicle to carry more payload at the same weight. Many of the electrical propulsion systems operate in pulse mode, pulsing hundreds or even thousands of times per second. Creating reliable valves that can operate in pulse mode for extremely long life and at low power are critical in these applications. In Phase 1 of this effort, WASK Engineering demonstrated the suitability using a piezo actuated valve to meet the requirements of electric thrusters. Valves actuated with piezo crystals offer the benefits of 1) a demonstrated ability to operate at frequencies from 0 Hz to over 1,000 Hz, 2) the ability to throttle continuously from 0-100% open, 3) extremely fast response, 4) low power usage, 5) opening the valve with infinitely variable operating waveforms, sine wave, square wave, saw tooth, custom wave form, etc., 6) no EMI generated, and 7) a very low part count for reliability

ANTICIPATED BENEFITS

To NASA funded missions:

Potential NASA Commercial Applications: Potential NASA applications include application of the valve to the propellant control for electric thrusters. This includes both continuous firing and pulse mode units. The valve's capability to throttle and readily adjust the frequency and pulse width of opening enables the possibility of easily operating a thruster at various average power levels, depending on mission requirements. When this effort is completed, the valve will have demonstrated an unprecedented cycle life. This will make it suitable not only as a valve for long duration missions with electric propulsion, but also for valves and regulators for satellites and space probes on long duration space missions. The valve can also be used, with some

Fast Acting Flow Control Valve

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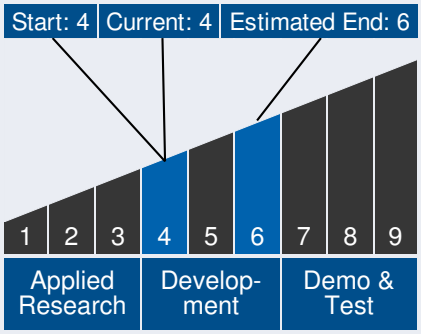
Technology Maturity



Management Team

Program Executives:

- Joseph Grant
- Laguduva Kubendran

Program Manager:

- Carlos Torrez

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minor modifications as a cold gas thruster. This would allow microsatellites a simple method of control while on orbit. The ability to throttle makes the control very effective, as the impulse bit can be adjusted from large to very small depending on the immediate requirement. This has the benefit of simplifying the control system due to the very small minimum impulse bit possible. For all of these applications, the combination of all the significant features of the valve, 1) throttling, 2) pulse mode operation at very high frequencies, 3) very small size, 4) very light weight, and 5) very low power requirement result in a very unique and innovative valve.

To the commercial space industry:

Potential Non-NASA Commercial Applications: The capabilities the current valve possesses will permit it to be used for flow control in pneumatic systems. The small size and low power consumption open the potential to use the valve in portable, battery powered applications. We are already evolving another piezo actuated valve for an application to actively control gas turbine combustion instabilities. In this effort we are developing relationships with jet engine fuel control companies such as Woodward Controls. This has benefits not only commercially but also militarily, as the Navy is evaluating alternatives for active combustion control in their jet aircraft. A second potential application is to apply this technology to rocket engine combustors. In current rocket engine developments, especially those using a heavy hydrocarbon fuel such as RP-1, combustion instability is an ongoing concern. Typical approaches significantly complicate the design. Incorporating a number of modulating valves into a small number of the injection elements in a combustor have the potential to counteract the devastating effects of the instabilities in rocket engines and significantly reduce development costs. To this end we have had discussions with both NASA rocket engineers and engineers at the Air Force Research Laboratory about the potential of pursuing this approach.

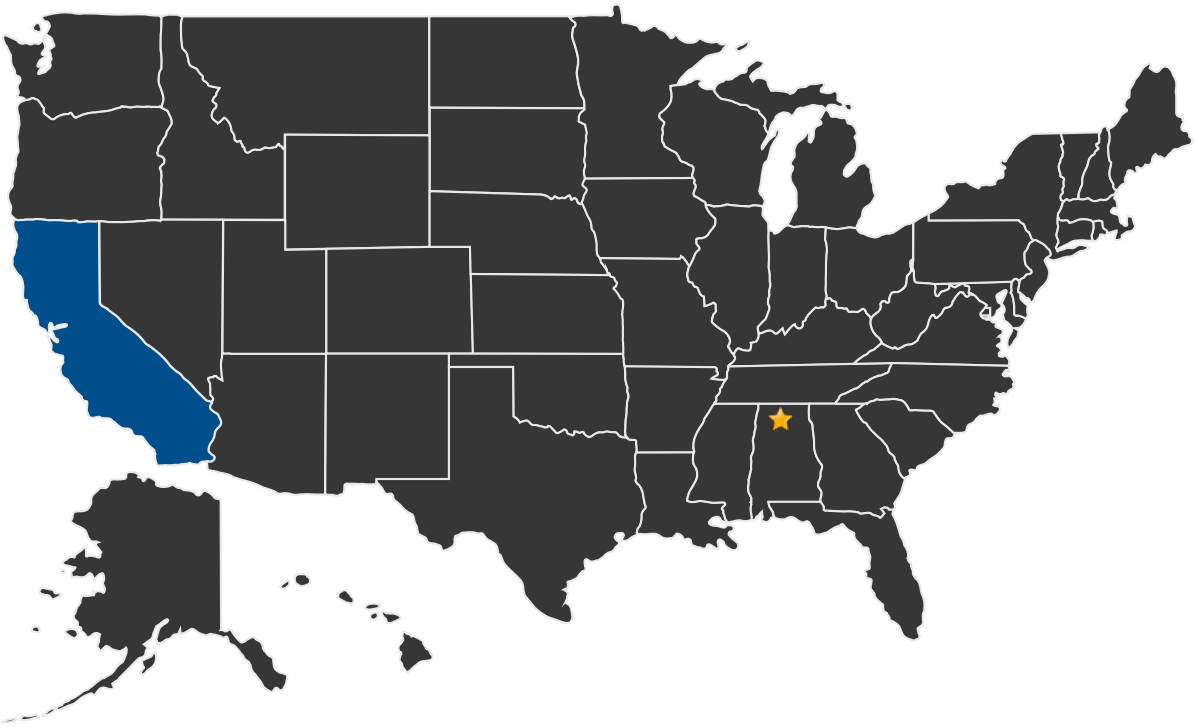
Management Team *(cont.)*

Principal Investigator:
- Wendel Burkhardt

Technology Areas

Primary Technology Area:
In-Space Propulsion Technologies (TA 2)
└ Non-Chemical Propulsion (TA 2.2)
  └ Electric Propulsion (TA 2.2.1)
    └ Pulsed Inductive Thruster (TA 2.2.1.3)

U.S. WORK LOCATIONS AND KEY PARTNERS



U.S. States With Work

Lead Center:
Marshall Space Flight Center

Other Organizations Performing Work:

- WASK Engineering, Inc. (Cameron Park, CA)

PROJECT LIBRARY

Additional Images

- Project Image
  - (This image is a .tif file. Please visit http://techport.nasa.gov:80/file/16961 to download this image to view it.)

Presentations

- Briefing Chart
  - (http://techport.nasa.gov:80/file/17783)

DETAILS FOR TECHNOLOGY 1

Technology Title

Fast Acting Flow Control Valve